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Emotions can bias decision-making processes by promoting specific behavioral tendencies

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We present recent evidence supporting the idea that emotions promote specific behaviors in an organism and that incidental emotion or affective cues will bias choices towards actions consistent with those behavioral goals. We review several strands of research in psychology, economics, and neuroscience showing that different emotions and mood states have specific behavioral effects on both individual and interpersonal decision-making that relate more to action tendencies than positive or negative valence. While early theoretical accounts of the influences of emotions on choice posited bidirectional valence-dependent effects on decision-making (e.g., Forgas, 1995), such accounts have proven to be too simplistic in light of the more recent results. Instead, the evidence reviewed in this chapter indicates that emotions bias various aspects of decision-making by priming choice-relevant cognitive mechanisms in a motivationally specific manner (e.g., Davidson, 1998; Gray, 2004; Harlé & Sanfey, 2010; Lang, Bradley, & Cuthbert, 1998). This notion is supported by recent neuroimaging results that demonstrate emotion-specific enhancement and suppression of brain activity within the valuation system.

Decision-making is a complex behavior that involves multiple component processes (Rangel et al., 2008: Rangel & Hare, 2010). In this chapter, we focus on goal-directed decision-making, a type of choice that involves at least the following steps: forming a perceptual representation of the choice problem, computing and comparing the values and costs of the available choice options, planning and executing an action to obtain the chosen outcomes, and learning about the outcomes of the decision to improve the quality of future choices. These choice processes are subserved by multiple cognitive mechanisms, including attention (e.g., Hare, Malmaud, & Rangel, 2011; Krajbich, Armel, & Rangel, 2010; Lim, O'Doherty, & Rangel, 2011), memory (e.g., Bechara & Martin, 2004; Hinson, Jameson, & Whitney, 2003), and learning (e.g., Niv, Edlund, Dayan, & O'Doherty, 2012; Schonberg, Daw, Joel, & O'Doherty, 2007; Schultz, 2002). As detailed in other chapters of this volume, research in cognitive and affective sciences has emphasized interactions between emotions and cognitive processes (see also Pessoa, 2008; Phelps, 2006). Thus, if emotion can influence the component processes that mediate decision-making, it stands to reason that affective states will have an impact on choices. Indeed, functional magnetic resonance imaging (fMRI) studies have revealed substantial overlap in the regions involved in basic cognitive processes, emotions, and decision-making (Figure 1). Figure 1 shows conjunction maps of regions that are consistently activated during decision-making, as well as emotional and cognitive processing. Given the well-documented influences of emotions on the cognitive processes that are important for decision-making, in conjunction with the significant overlap in the neural circuitry of these processes, emotional effects on decision-making are not surprising. We believe that a more interesting question is how and why a particular emotion affects choice in a specific way.

Current theoretical accounts of the influences of emotion on choice distinguish between two types of emotional influences: anticipatory and incidental emotions (e.g., Loewenstein & Lerner, 2013). Anticipatory emotions are a direct part of the decision process and are experienced when a decision maker simulates the outcomes of choice options, such as the anticipated pleasure associated with consuming a good that forms the possible outcome of a decision. Incidental emotions, on the other hand, are by definition unrelated to the outcomes currently under consideration, but they may still cause alterations in choice processes. Incidental emotions are of particular interest for the study of the influences of emotion on choice because of their ubiquity in real life (we rarely make choices in an emotional vacuum) and because they can bias choices in specific ways, as we will discuss.

Emotional States Influence Decision-Making Under Risk

One way to investigate the influence of incidental emotions experimentally is to induce an emotional state via mood induction. The most commonly used mood induction techniques expose participants to emotionally valenced material in the form of brief texts or short movie clips that subsequently induce a discrete emotional state (e.g., Gross & Levenson, 1995). In one of the first studies investigating the influence of mood on decision-making, Johnson and Tversky (1983) asked participants to read newspaper articles designed to induce either negative or positive moods (Johnson & Tversky, 1983). The authors assessed the subsequent mood-induced change in risk perception via a questionnaire that asked participants to estimate the frequency of annual fatalities in risk categories ranging from diseases (e.g., heart disease) and natural hazards (e.g., tornados) to violence (e.g., homicide). They found that negative mood states were associated with a general increase in participants’ estimates of fatality likelihoods, while positive mood states were associated with decreases in such risk estimates.

However, subsequent work has shown that specific emotions influence risky choices in a motivationally specific manner. Regardless of valence, emotions associated with withdrawal and avoidance lead to risk aversion, while emotions that promote approach behaviors generally increase risk-seeking. For example, Raghunathan and Phan showed that different moods within the same negative valence category (sadness vs. anxiety) have distinct effects on risk preferences. Sadness increased preferences for a higher-risk gamble (e.g., 30% of $10), while anxiety shifted preferences towards expected value matched lower-risk gambles (e.g., 60% of $5) (Raghunathan & Pham, 1999). A related study by Lerner and Keltner (Lerner & Keltner, 2001) showed similar action-tendency specific effects of two negatively valenced emotions. In this case, fear (avoidance) was associated with avoiding risk, while anger (approach) was associated with risk-seeking choices.

While research using emotion induction has yielded many important insights into the effects of mood on decision-making, experiments using mood induction often suffer from confounds, which include demand effects as well as unpredictable and/or brief durations of the emotional state (Martin, 1990; Westermann, Spies, Stahl, & Hesse, 1996). An alternative method to investigate incidental emotion effects on choice is affective priming (Klauer, 1997). A recent study combined the methods of affective priming and threat-of-shock to investigate the role of fear in risky decision-making (Cohn, Engelmann, Fehr, & Maréchal, 2015). Threat of shock has been shown to reliably induce anticipatory fear and anxiety (Schmitz & Grillon, 2012) and has the advantage of allowing within-participant manipulation of the emotional state, thereby controlling for preexisting individual differences in risk preferences and personality characteristics that can influence decision-making (e.g., Capra, Jiang, Engelmann, & Berns, 2013). In the study by Cohn et al. (2015), participants were placed in two conditions. In the threat condition, participants were administered unpredictable and mildly painful electrical shocks that were incidental to choices over lotteries. The safe condition was matched in every respect, except that the shocks were not painful and thus did not produce anxiety or fear. The results indicated that under conditions of fear, average investments into the ambiguous lotteries were significantly reduced. It should be noted that these results were explained by the emotional reaction to the fearful expectation of electrical shocks, and not the actual experience of the shocks.

To date, enhanced fear and anxiety have consistently been associated with more risk-averse decision-making (Cohn et al., 2015; Johnson & Tversky, 1983; Kuhnen & Knutson, 2011; Lerner & Keltner, 2001; Raghunathan & Pham, 1999), while emotions such as happiness or anger have been associated with more risk-seeking choices (Isen & Patrick, 1983; Johnson & Tversky, 1983; Lerner & Keltner, 2001). Fear and anxiety related responses serve a clear function to protect the organism, and to this end, they prioritize cognitive mechanisms involved in defensive behaviors, such as withdrawal and behavioral inhibition. Therefore, it is logical that such withdrawal-related emotional states lead to more risk-averse choices. Anger and happiness, on the other hand, are approach-related emotional states that potentiate cognitive mechanisms supporting approach tendencies and reward-seeking, thereby leading to more risk-seeking choices. The behavioral results reviewed here are therefore consistent with the view that emotions exert *motivationally specific* effects on risky decision-making (e.g., Davidson, 1998; Gray, 2001; Lang et al., 1998). This may occur via emotional tuning of choice-relevant cognitive systems to the general situational demands (Gray, 2001, 2004). Such emotional tuning might relate to and rely on biologically prepared Pavlovian responses that have been shown to influence decision-relevant cognitive processes (Dayan & Niv, 2008; Ly, Huys, Stins, Roelofs, & Cools, 2014; Seymour & Dolan, 2008).

The Influence of Emotions Generalizes to Other Choice Domains

Emotions and mood also exert specific influences on economic choices outside the domain of risk. Lerner et al. (2004) showed that sadness leads to a reversal of the well-established “endowment effect” (i.e., asking a higher selling price for items one owns) (Lerner, Small, & Loewenstein, 2004). Specifically, sadness significantly decreased individual’s selling prices and increased the amount they were willing to pay relative to neutral mood. In contrast, disgust, another emotion with negative valence, had a distinct effect: it reduced both selling and buying prices. In addition, emotions have also been shown to influence intertemporal decisions that entail choosing between a more proximal but smaller, and a delayed but larger, reward. In one study, sad participants were significantly more impatient than disgusted and neutral participants, and were able to better and more quickly justify their choices for the “sooner” outcome (Lerner, Li, & Weber, 2013). Another intertemporal choice study by Luo et al. (2014) showed that affective priming with happy facial expressions was associated with more impatient choices compared to fearful facial expressions (Luo, Ainslie, & Monterosso, 2014). Together, these results underline the specific influences of emotions on motivational processes related to purchasing and intertemporal decisions, such that the willingness to purchase products was enhanced by sadness and reduced by disgust, while the focus on instant gratification was enhanced by both sadness and happiness.

Lastly, incidental affective states have also been demonstrated to influence interpersonal, social decisions. Harlé and Sanfey (2007) induced incidental sad, happy, and neutral moods via film clips and subsequently asked participants to play the ultimatum game (UG) in the role of the responder (Harlé & Sanfey, 2007). Participants in the sad mood state showed greater rejection rates of unfair offers from the proposer, relative to participants who underwent happy and neutral mood induction. Findings from Moretti and di Pelegrino (2010) showed that participants who had viewed disgusting pictures prior to choosing were more likely to reject unfair offers. Interestingly, these observations were specific to interactions with human counterparts, as no disgust effects were observed when participants interacted with a computer. In a follow-up study, Harlé and Sanfey (2010) investigated the impact of specific emotions that simultaneously varied in the positive–negative valence and approach–withdrawal motivational dimensions on UG decisions (Harlé & Sanfey, 2010). Thus, the experimental design allowed for a dissociation of the influences of emotional valence and motivation dimensions on decision-making. They found that the approach–withdrawal motivational dimension significantly predicted rejection rates for unfair offers, but that the valence dimension was not predictive of choice. Specifically, withdrawal-related emotions were associated with more rejections relative to approach-related emotional states, regardless of valence. These results extend the view that emotions influence decision-making in a motivationally specific manner, and that the effects can be seen across the domains of risky, purchasing, and social decision-making.

Emotional Influences on the Neural Circuitry of Choice

Although there is a wealth of behavioral findings in psychology and economics, our understanding of the neural circuitry that underlies the influences of incidental emotions on decision-making is still a work in progress. However, recent experiments have begun to investigate and shed light on these questions.

Emotions associated with approach motivations have been shown to enhance activity in the brain's valuation circuitry. Using affective priming, Knutson et al. (2008) investigated the influence of incidental emotion on the neural correlates of choice (Knutson, Wimmer, Kuhnen, & Winkielman, 2008). Emotionally charged positive (erotic couples), negative (snakes, spiders), or neutral images (household goods) were shown immediately before risky decisions. Behaviorally, positive pictures increased the participants' willingness to take risks, relative to neutral and negative stimuli. At the neural level, ventral striatum (VS) activity was associated with viewing arousing positive stimuli, and predicted shifts from risk-averse to risk-seeking choices. Moreover, signal in VS partially mediated the effect of positive stimuli on risky choices. These results indicate that positive emotional states can enhance VS activity, and that this increased activity is associated with changes in decision making. Such transient increases in neural activity within the valuation network may be the underlying neural basis of the behavioral effects of approach-related emotions reviewed before.

Distinct changes in the activity of the brain's valuation circuitry can also be seen for emotions promoting avoidance and withdrawal. A recent fMRI study by Engelmann et al. (2015) investigated how anticipatory anxiety affects the neural circuitry involved in risky decision-making. Anticipatory anxiety was induced via the threat-of-shock procedure outlined previously (see also Schmitz & Grillon, 2012). Engelmann et al. showed that incidental anxiety significantly influenced the neural signature of value-coding during decision-making. Specifically, in the absence of anticipatory anxiety, trial-by-trial signal in ventromedial prefrontal cortex (vmPFC) and VS tracked the subjective value of choice options. This relationship between VS/vmPFC signal and subjective value collapsed during anticipatory anxiety, but neural coding of negative subjective value in anterior insula was increased. These results suggest a context-dependent shift in value coding from predicting positive consequences during safety, toward a focus on possible negative outcomes during anticipatory anxiety. Importantly, this change in neural value coding was linked to choice behavior. Choices under conditions of safety could be explained by Blood-oxygenation-level dependent (BOLD) signals in the vmPFC and VS, but not insula, whereas choices under conditions of threat were correlated with the insula signal, but not vmPFC and VS signals. This pattern of insula activity is consistent with its reported role in mediating the influence of sadness on rejecting unfair monetary splits in a two-person ultimatum game (Harlé, Chang, van't Wout, & Sanfey, 2012). The relative switch from positive to negative value coding may occur because anticipatory anxiety reduces the sensitivity of regions involved in positive value coding. Specifically, the vmPFC showed suppression in both activation magnitude and degree of functional connectivity with VS and insula during threat. This suppression of activity and functional coupling between valuation areas under conditions of anxiety is consistent with previous reports (Talmi et al., 2009) and may reflect a reduction in the coding of choice-relevant subjective values in favor of coding the more salient emotional value of the affective context (Winecoff et al., 2013).

As a whole, these neuroimaging findings demonstrate distinct neural effects of approach- and withdrawal-related emotional states. On one hand, approach-oriented emotional stimuli have been shown to enhance activity in core valuation systems, which in turn predicts more risk-seeking choices (Knutson, Wimmer, Kuhnen, & Winkielman, 2008). On the other hand, avoidance- and withdrawal-related emotions reduce activity within these core valuation systems, and promote aversive value coding in the insula (Engelmann, Meyer, Fehr, & Ruff, 2015). To date, there are no imaging studies comparing the effects of two similarly valenced emotions differing in approach and withdrawal motivations (e.g., fear vs. anger) on neural activity during choice. In the future, such investigations will be critical for completely dissociating the effects of valence and action motivation on neural activity during goal-directed choice. Nevertheless, current findings clearly demonstrate that value related activity within the brain's decision circuitry flexibly depends on the emotional context, and emphasize the need to consider emotional context as an important behavioral and neural modulator of valuation (see also Engelmann & Hein, 2013; Seymour & McClure, 2008).

Conclusion

Incidental emotions can influence decision-making across a variety of goal-directed choice domains. Moreover, emotions influence decisions in motivationally specific ways along an axis of approach and avoidance tendencies that are not strictly dependent on positive or negative valence. One prominent mechanism through which emotions appear to influence decisions is via emotional tuning of choice-relevant neural circuitry to promote approach- or withdrawal-related actions. However, our knowledge of how emotion is integrated into choice at the neurobiological level is far from complete, and this important topic is ripe with questions for future research.

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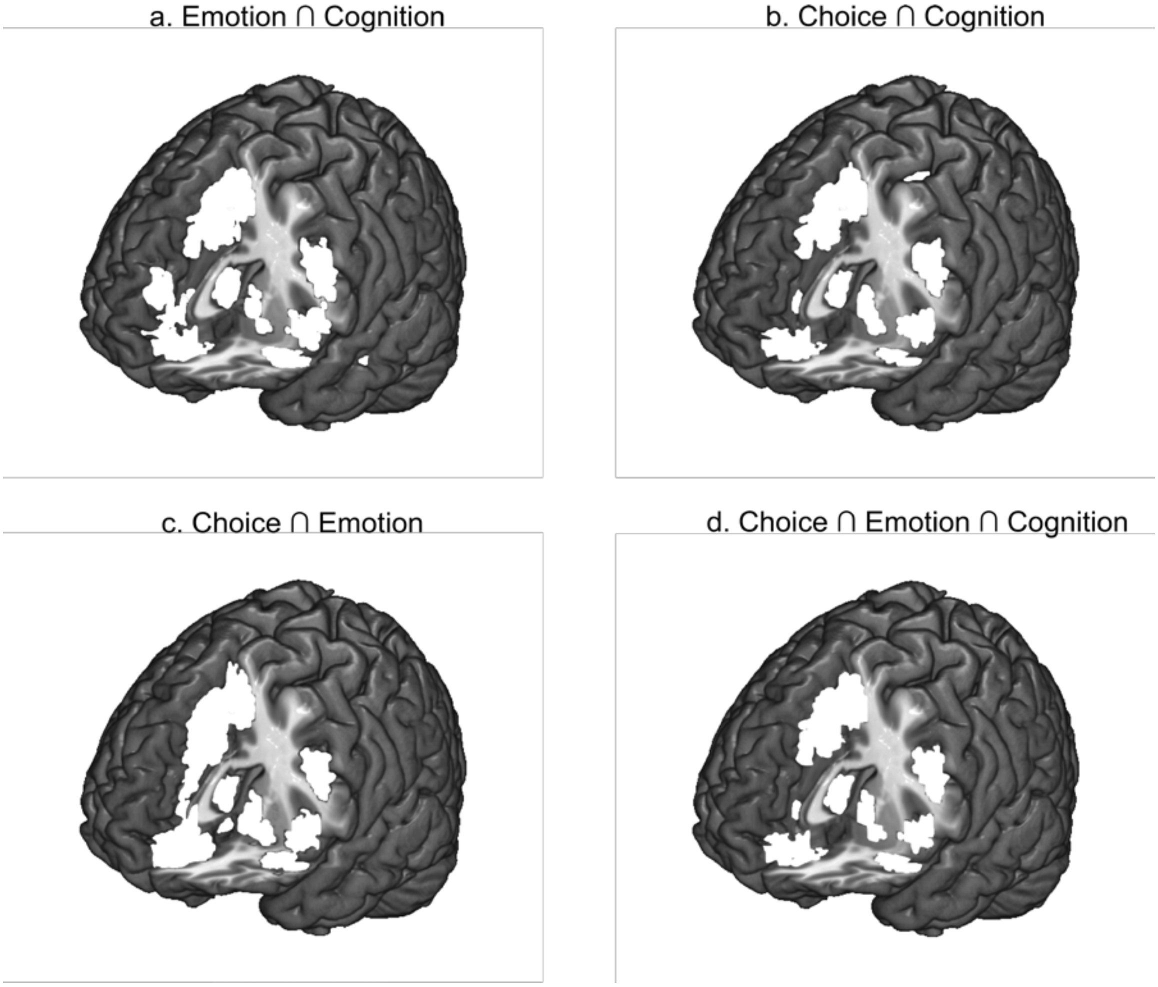

Figure 1. Conjunction maps of neurosynth automated meta-analyses for the terms cognition, emotion and decision-making. Conjunction maps show significant overlap between the neural circuitry that is consistently (but, due to the use of forward inference maps, not specifically) recruited during cognition, emotion and decision-making. Importantly, overlap occurs in core valuation regions that include VMPFC, VS, insula, as well as amygdala (not shown here). Such significant overlap in the neural circuitry subserving choice processes is consistent with the notion that interactions between cognitive and emotional processes influence decision-making.